

What is claimed is:

- 1 1. A method of transmitting optical signals comprising:
 - 2 (a) providing a first optical fiber having a plurality of spaced apart sections
3 doped with a material that acts as an optical amplifier upon supply of
4 optical energy thereto;
 - 5 (b) providing a second optical fiber adjacent the first optical fiber and
6 coupling the second optical fiber to each of the plurality of spaced apart
7 doped sections; and
 - 8 (c) pumping optical energy from a remote source through said second optical
9 fiber to each of said plurality of doped sections in said first optical fiber to
10 amplify optical signals passing through said first optical fiber.
- 1 2. The method of claim 1 further comprising encapsulating each of the plurality of
2 doped sections and the corresponding coupling between the first and the second
3 optical fibers.
- 1 3. The method of claim 1 further comprising enclosing the first and the second fiber
2 in a protective enclosure.
- 1 4. The method of claim 3 wherein the enclosure is a tubing.

1 5. The method of claim 4 wherein the tubing is one of a (i) polyurethane (ii) steel;
2 or (iii) a composite material.

1 6. The method of claim 1 further comprising introducing optical signals to be
2 transmitted into the first fiber.

1 7. The method of claim 1 further comprising coupling at least one sensor to the
2 first optical fiber.

1 8. The method of claim 1 further comprising coupling a plurality of distributed
2 optical sensors to the first fiber.

1 9. The method of claim 7 wherein said at least one sensor is selected from a group
2 consisting of (i) a temperature sensor; (ii) a pressure sensor; (ii) a flow measurement
3 sensor; (iv) a sensor for determining a chemical characteristic of a fluid; and (v) a sensor
4 for determining a physical characteristic of a fluid.

1 10. A fiber optic signal system comprising:

2 (a) a first optical fiber having a plurality of spaced apart doped sections
3 having a material that amplifies optical signals passing therethrough upon
4 supply of optical energy to said each of said plurality of spaced apart
5 doped sections; and

6 (b) a second optical fiber adjacent said first optical fiber and optically coupled
7 to each of said plurality of doped sections, said second optical fiber having
8 optical energy pumped therethrough for supplying optical energy to each
9 of said plurality of doped sections to amplify optical signals carried by
10 said first optical fiber .

1 11. The fiber optic signal carrier of claim 10 further comprising an enclosure
2 enclosing the first and the second optical fibers.

1 12. The fiber optic signal carrier of claim 10 wherein each of the plurality of doped
2 sections includes a separate optical coupling between the second optical fiber and each of
3 said plurality of doped sections in said first optical fiber.

1 13. The fiber optic signal carrier of claim 12 wherein each of the plurality of doped
2 sections and the corresponding optical coupling are encapsulated.

1 14. The fiber optic signal carrier of claim 10 further comprising at least one sensor
2 coupled to the first optical fiber, said sensor providing optical signals to said first optical
3 fiber.

1 15. The fiber optic signal carrier of claim 14 wherein the at least one sensor is
2 selected from a group consisting of (i) a temperature sensor; (ii) a pressure sensor; (iii) a
3 flow measurement sensor; and (iv) a sensor providing a measure of a fluid characteristic.

1 16. The fiber optic signal carrier of claim 10 further comprising a third optical fiber
2 having a plurality of doped sections and placed alongside of the first and second optical
3 fibers for carrying signals in a direction opposite of a direction of signals carried by the
4 first optical fiber.

1 17. The fiber optic signal carrier of claim 16 further comprising an optical coupler
2 between the second optical fiber each of the plurality of doped sections of the third
3 optical fiber.

1 18. The fiber optic signal carrier of claim 14 wherein the at least one sensor includes
2 a plurality of sensors placed spaced apart along a length of the first optical fiber.

1 19. A system of transmitting optical signals during a subsea oilfield operations
2 comprising:

3 (a) a fiber optical signal carrier extending under water, said fiber optical
4 signal carrier including:

- 5 (i) a first optical fiber having a least one doped section that acts as an
6 amplifier to optical signals passing there through when said doped
7 section is supplied with optical energy;
- 8 (ii) a second optical fiber disposed alongside the first optical fiber for
9 carrying optical energy;
- 10 (iii) an optical coupler between the second optical fiber and the at least
11 one doped section for supplying optical energy from the second
12 optical fiber to the first optical fiber;
- 13 (b) at least one optical signal traveling in the first optical fiber; and
- 14 (c) an optical energy source supplying optical energy to the second optical
15 fiber.

1 20. The system of claim 19 wherein the optical energy source is located remotely
2 from said doped section.

1 21. The system of claim 19 wherein the optical signal carrier is disposed in part in a
2 subsea wellbore.

1 22. The system of claim 19 wherein at least a portion of the optical signal carrier is in
2 a subsea pipeline carrying fluids.

1 23. The system of claim 19 wherein the at least one optical signal is at least one of (i)
2 a sensor signal and (ii) a communication signal.

1 24. The system of claim 23 wherein the sensor signal is generated from at least one
2 sensor optically coupled to said first optical fiber.

1 25. The system of claim 24 wherein the sensor is one of (i) a pressure sensor; (ii) a
2 temperature sensor; (iii) a flow measurement sensor; and (iv) a sensor providing a
3 measure of a characteristic of a fluid.

1 26. A fiber optic signal carrier, comprising:

2 a. a first optical fiber carrying a first optical signal in a first direction, said first
3 optical fiber having a plurality of spaced apart first doped sections, said first
4 doped sections having a material that amplifies optical signals passing
5 therethrough upon supply of optical energy to said plurality of first doped
6 sections;

7 b. a second optical fiber adjacent said first optical fiber and carrying a second
8 optical signal in a second direction, said second optical fiber having a plurality
9 of spaced apart second doped sections, said second doped sections having a
10 material that amplifies optical signals passing therethrough upon supply of
11 optical energy to said plurality of second doped sections; and

12 c. an optical pumping fiber adjacent said first optical fiber and said second
13 optical fiber, said optical pumping fiber optically coupled to each of said
14 plurality of first doped sections and second doped sections for supplying
15 optical power to said doped sections thereby amplifying said first optical
16 signal and said second optical signal.